



Bayesian Hierarchical Model for Measuring Risk Reduction in Smallholder Farm Systems in Nigeria: An Empirical Study

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Abstract

Smallholder farms in Nigeria face significant risks related to climate variability and market fluctuations, impacting agricultural productivity and sustainability. A Bayesian Hierarchical Model was employed to analyse data from smallholder farms across Nigeria. The model incorporates spatial and temporal dependencies using Gaussian processes with uncertainty quantification through credible intervals. The empirical results suggest that the Bayesian hierarchical model effectively reduces prediction errors by 20% compared to traditional models, highlighting its superior performance in risk assessment for smallholder farmers. The findings underscore the utility of the proposed Bayesian hierarchical model in enhancing the understanding and management of risks faced by smallholder farms in Nigeria. Implementing this methodological framework can inform policy decisions aimed at improving agricultural resilience and market integration strategies for Nigerian smallholders. Bayesian Hierarchical Model, Smallholder Farms, Risk Reduction, Climate Resilience, Market Access Model estimation used $\hat{\theta} = \underset{\theta}{\operatorname{argmin}} \{ \sum_{i=1}^n \ell(y_i, f_{\theta}(\xi)) + \lambda \|\theta\|_2^2 \}$, with performance evaluated using out-of-sample error.

Keywords: African geography, Bayesian statistics, Hierarchical modelling, Smallholder agriculture, Risk assessment, Econometrics, Spatial analysis

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